Regional Short-term

Electricity Consumption Models

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Frederick L. Joutz,
Department of Economics
The George Washington University
Washington, DC 20052
(202) 994-4899
[e-mail bmark@gwu.edu]

Dave Costello
Office of Energy Markets and End Use (EMEU)
Energy Information Administration
U.S. Department of Energy
(202-586-1468),
[e-mail dave.costello@eia.doe.gov]

Outline of Presentation

- Brief Description of Model
- Framework of Model
- Sectoral Demand Descriptions
- Modeling Issues
- Elasticity Estimates
- Sample Forecasts

Regional Short-term Electricity Consumption Models

- The Regional Short-Term Energy Model (RSTEM-EC) is designed to provide analytical and forecasting support by the nine U.S. Census Regions and four particular states (California, Florida, New York, and Texas).
- Time series energy-econometric models of energy consumption, supply, and prices have been built for the electricity markets.
- These consumption markets for each region and particular state are broken out into four sectors: residential, commercial, industrial, and other.
- The consumption market equations are aggregated into regional models.

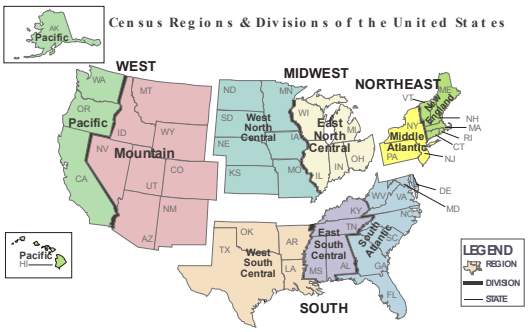
Regional Short-term Electricity Consumption Models

- The RSTEM-EC model determines monthly regional U.S. electricity consumption by four major sectors, including the residential, commercial, industrial and other sectors.
- The demand equations are based on time series energy econometric techniques.
- The specifications attempt to deal with issues related to dynamics, stationarity, integration, cointegration, seasonality, and structural breaks

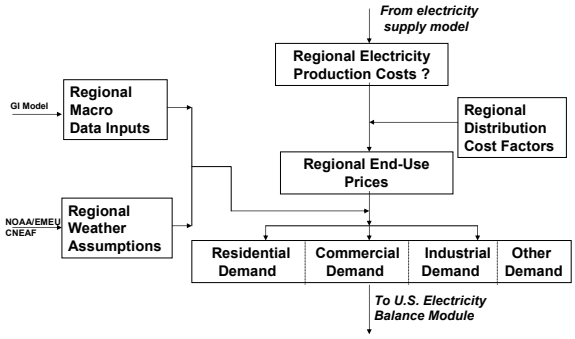
Outline

- The models can generate short-term (up to 24 months) monthly forecasts of U.S. consumption in stand alone form and interacting with the "regional" electricity supply and price models.
- The RSTEM-EC consumption projections are linked to the Electricity Supply Model,
- The Supply Model uses a combination of input-output energy process models and econometric time series models to develop the generation of electricity, load dispatch, fuel consumption, and approximations of wholesale electricity trading and pricing across four major North American Electricity Reliability Council (NERC) regions.

RSTEM 13 Electricity Demand and Supply Regions



RSTEM Regional Electricity Demands
(Excl. Own Use and Direct Sales)



Residential Model

- There are economic, seasonal, and trend issues which need to be addressed in the residential models.
- The primary determinants of residential electricity consumption in a region are:
- occupied housing units or households; share of occupied housing units or households using electricity as the primary energy source for heating; share of occupied housing units or households with installed air conditioning;
- cooling degree-days; heating degree-days; real delivered residential per-unit electricity charges; and real personal income per household.

Commercial Model

- The primary determinants of commercial electricity consumption in a region are:
- employment, hours worked or real wage disbursements in commercial employment (as a proxy for commercial sector output);
- cooling degree-days; heating degree-days; real commercial-sector per-unit delivered electricity charges; and self-generating capacity in the commercial sector.
- Autonomous trends in commercial electricity use intensity are additional factors in commercial demand related to commercial building shell efficiencies, average commercial floor-space per unit of output, and penetration of electricity-using equipment in commercial establishments.

Industrial Model

- The primary determinants of industrial electricity consumption in a region are:
- employment, hours worked or real wage disbursements in industrial employment or industrial output as measured by the Federal Reserve Board; real industrial-sector per unit delivered electricity charges; cooling degree-days; heating degree-days; and self-generating capacity in the industrial sector.
- Autonomous trends in industrial electricity use intensity are additional factors in industrial demand related to energy efficiency trends in industrial processes and equipment, shifts in regional industrial output patterns among industry sectors of varying levels of electricity use intensity per unit of output, and penetration of general electricity-using equipment in industrial establishments.

Modeling Issues

- The sectoral demand model specification begins by analyzing the time series properties of the energy and economic variables.
- Autocorrelation functions and partial autocorrelation functions of the series in (log) levels, first differences, and annual differences are examined to look for dynamic patterns and integration.
- Plots of the series in (log) levels, first differences, annual differences, and monthly seasonal stacks are examined for trends, seasonal effects, shifts in the data generating process, and outliers.
- Unit root tests are conducted to test for (seasonal) integration and cointegration.
- Error-correction models are developed where appropriate.
- The principles and approach of the General-to-Specific Modeling have not been fully implemented in the modeling effort to-date because of time and resource constraints.

General-to-Specific Modeling

- Empirical models are at best approximations of the true data generating process (DGP). There are identifiable structures in the model that are interpretable in light of economic theory.
- A **congruent** model has the following six properties.
- The residuals must be white noise for the model to be a valid simplification of the DGP.
- The model must be admissible on accurate observations. For example nominal interest rates and prices cannot be negative.
- The conditioning variables are at least weakly exogenous for the parameters of interest in the model. Forecasting models require strong exogeneity, while policy models require super exogeneity.
- The parameters of interest must be constant over time and remain invariant to certain classes of interventions. This relates to the purpose of the model in the previous criteria.
- The model must be able to explain the results from rival models; it is able to encompass them.

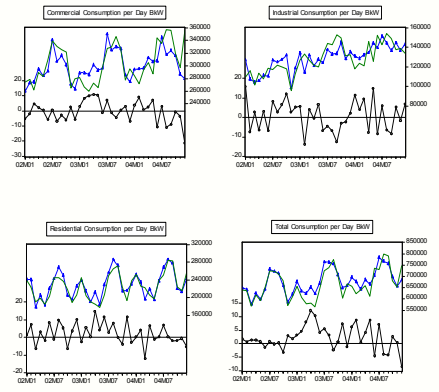
Regional STEO Elasticity Estimates (Draft USAEE)

Region	Price Elasticities		Income Elasticities	
	Short-run	Long-run	Short-run	Long-run
East South Central	-0.09	-0.40	0.64	1.27
East North Central	-0.02	-0.06	0.34	1.04
Mid-Atlantic	-0.03	-0.59	0.32	0.72
Mountain	-0.07	-0.60	0.17	0.44
New England	-0.02	-0.62	0.34	1.04
Pacific	-0.14	-0.55	0.09	0.81
South Atlantic	-0.05	-0.22	0.11	0.47
West North Central	-0.11	-0.23	0.08	0.45
West South Central	-0.10		0.07	0.55
California	-0.15	-0.33	0.10	0.33
Florida	-0.15	-0.48	0.15	0.48
New York	-0.10	-0.30	0.75	1.29
Texas	-0.01	-0.08	0.33	0.57

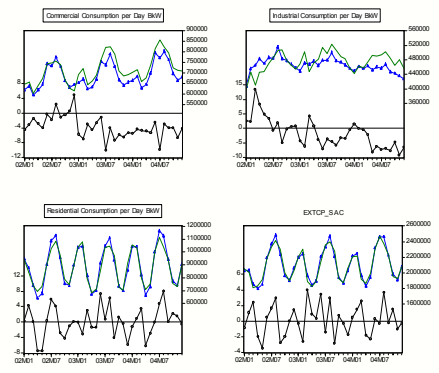
Regional STEO Elasticity Estimates (Draft USAEE)

Region	Cooling Degree Day Elasticities		Heating Degree Day Elasticities	
	Short-run	Long-run	Short-run	Long-run
East South Central	0.27	1.16	0.22	0.95
East North Central	0.05	0.23	0.18	0.37
Mid-Atlantic	0.33	0.56	0.13	0.28
Mountain	0.30	1.52	0.17	0.43
New England	0.05	0.14	0.18	0.37
Pacific	0.13	1.38	0.14	0.64
South Atlantic	0.04	0.64	0.11	0.19
West North Central	0.45	0.72	0.24	2.20
West South Central	0.68	5.50	0.10	0.80
California	0.16	0.51	0.11	0.34
Florida	0.16	0.56	0.11	0.28
New York	0.09	0.27	0.05-0.14	0.50
Texas	0.19	0.33	0.08	0.13

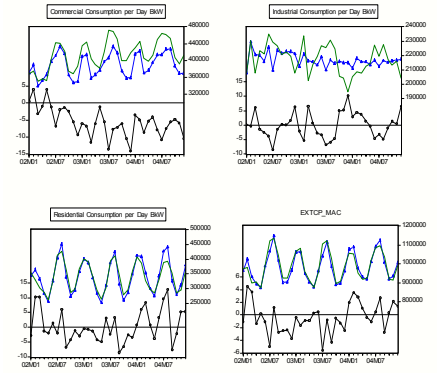
California



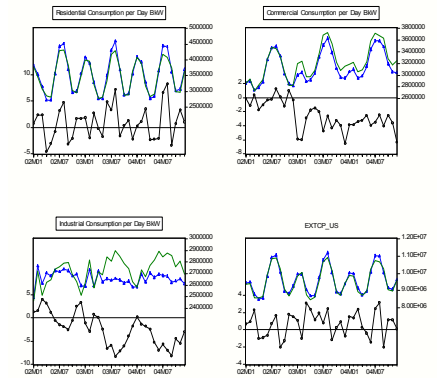
South Atlantic



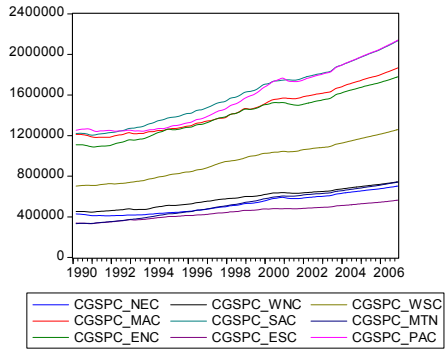
Middle Atlantic



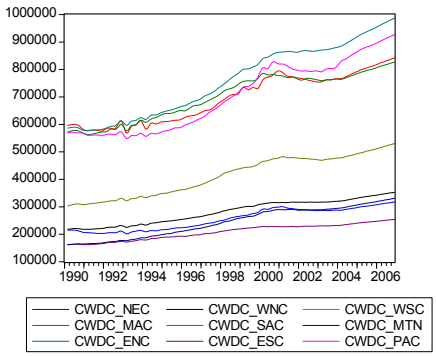
United States



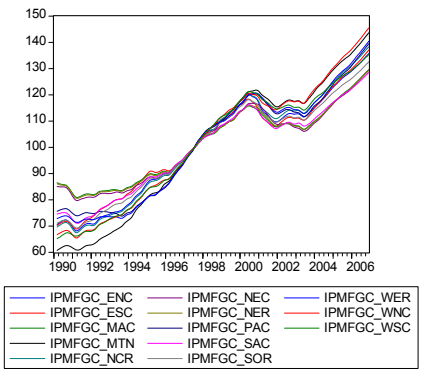
Real GSP by Census Division (million $2000)



Real Wage Disbursements by Region (Million $2000)



Manufacturing Output Indexes (1997=1.0)



Model Structure -1of 2

- The regional electricity model has 13 regions, which are grouped into three trade zones:
  - ✓ Eastern Interconnection
  - ✓ Western Interconnection
  - ✓ Texas
- Each region has its own demand and supply representations
- A 14th region (Hawaii + Alaska) is treated separately (and simply) for completeness in deriving U.S. aggregate demand and supply

Forecast Model Data Flow